⑲日本国特許庁(JP)　⑪特許出願公開

⑫公開特許公報(A)　昭61－256568

⑤1Int.Cl.⁴	識別記号	庁内整理番号	㊸公開 昭和61年(1986)11月14日
H 01 M 8/02		R－7623－5H	

審査請求 未請求 発明の数 1 (全4頁)

㊹発明の名称　燃料電池

㉑特　願 昭60－96754

㉒出　願 昭60(1985)5月9日

㉒発明者　酒井　勝則　川崎市川崎区浮島町2番1号　株式会社東芝浜川崎工場内

㉑出願人　株式会社東芝　川崎市幸区堀川町72番地

㉔代理人　弁理士 則近 憲佑　外1名

明　細　書

1. 発明の名称

燃料電池

2. 特許請求の範囲

1) 燃料が流通する燃料流通路と、酸化剤が流通する酸化剤流通路とを有する一対のガス拡散電極間に電解質を保持する電解質マトリックスが挟持される単位セルをガス不透過性セパレータプレート介して順次複数個積層してなる燃料電池において、上記燃料流通路および／または酸化剤流通路の上流側断面積が下流側断面積よりも大きくなるよう構成した燃料電池。

2) 前記セパレータプレートに上流側断面積が下流側断面積より小さい凸部を設け、この凸部を燃料流通路および／または酸化剤流通路にはめ込んだことを特徴とする特許請求の範囲第1項記載の燃料電池。

3. 発明の詳細な説明

〔発明の技術分野〕

本発明は燃料電池に係り、特に電池の燃料流通路又は酸化剤流通路の構造に関する。

〔発明の技術的背景とその問題点〕

従来燃料の有しているエネルギーを直接電気的エネルギーに変換する装置として燃料電池が知られている。この燃料電池は、通常電解質を挟んで一対の多孔質電極を配置するとともに、一方の電極背面に水素等の流体燃料を接触させ、また他方の電極の背面に酸素等の流体酸化剤を接触させ、このとき起る電気化学反応を利用して、上記電極間から電気エネルギーを取り出す様にしたものであり、前記燃料と酸化剤が供給されている限り高い効率で電気エネルギーを取り出すことができるものである。第5図(a)(b)は従来の燃料電池の構成を示す部分断面図と底断面図である。

第5図(a)において単位セルは電解質を含浸したマトリックス1に接する面に触媒が付加されているアノードリブ付電極2及び下側に多孔質体で形成されマトリックス1に接する面に触媒が付加されているカソードリブ付電極3と配置し構成される。上記リブ付電極2,3はそれぞれリブ4,5によって互いに直行す

るような向きに溝7，8が複数本規則的に平行に設けてあり、これらの溝7,8はそれぞれ流体燃料および流体酸化剤の流通路を構成する。上記のように構成された単位セル20をガス不透過性、耐熱性及び耐リン酸性セパレータープレート9を介し、複数個積層して、積層セル10が形成される。

第5図(b)において上記積層セル10は、その上下をシール用導体11で挟みこまれ、さらにその上下に配置された締付金具12により積層方向に締付固定して電池本体30が形成される。さらにこのように積層した電池本体30に流体燃料、例えば水素と、流体酸化剤例えば空気を供給及び排気するものとして電池本体の側面にマニホールド13を、フッ素ゴム系の成形パッキング14を配置すると共に、電池本体と成形パッキング14の間にフッ素樹脂系のシール材15を介在させて固着し、各単位セルに一括して燃料および酸化剤を供給排出するように構成している。

ところで、燃料ガスに含まれる水素、酸化剤ガスに含まれる酸素は、それぞれ流通路である溝7，8と通過中に、このときに起る電気化学反応により連続的に消費される。そのため、流通路である溝7，8の入口付近では、水素及び酸素分圧が高なり、溝7，8の出口に近づくにつれて分圧は小さくなる。この結果、電気化学反応は分圧の高い流入溝、7，8入口付近で生じやすくなり、セル平面の電流密度分布は、第2図に示す如く末端にいく程悪くなることがわかる。

以上の事より、セル有効面積から算出した電流密度で運転しても、局部的に高電池密度部が生じるため、特に高利用率運転時では、その部分が限界電流密度に近い領域となり、全体のセル特性に悪影響を及ぼす等の問題がある。また長時間の電池運転においても局部的に電流密度の高い部分はリン酸の持ち出しが増加し、反応点の減少・劣化につながる。これにより電池寿命にも大きく悪影響を及ぼす等の問題がある。

〔発明の目的〕

本発明は上記事情に鑑みてなされたものでその目的は電池の電流密度分布を流体の流れ方向に沿って均一にし、供給ガス高利用率領域でセル特性が良好で、かつ長寿命で信頼性のある燃料電池を提供することにある。

〔発明の概要〕

上記目的を達成するために本発明は燃料電池の燃料流通路および/または酸化剤流通路の上流側断面積が下流側断面積よりも大きくなるよう構成したことを特徴とする。

〔発明の実施例〕

以下本発明の一実施例について図面を参照して説明する。

第1図(a)において、セパレータープレート9がカソードリブ付電極3に接する面に、カソード溝8の幅より小さく、かつカソード溝8入口から出口へかけて、徐々に山が高くなる様に凸部16を、前記カソード溝8と同数でかつ溝に合致するよう規則的に、平行に設ける。

またセパレータプレート9の前記凸部16の反対側の面には凸部16と直交する方向にアノード溝7の幅より一回り小さくかつアノード溝7入口から出口へかけて、徐々に山が高くなる様に凸部17を前記アノード溝7と同数でかつ溝に合致するよう規則的に平行に設ける。

次に前述の如く構成したセパレータプレート9を図1(b)に示す如く、第2，3の溝7，8とセパレータプレート9の凸部16，17が合うようそして4/3燃料及び酸化剤流通溝断面積が入口から出口にかけて徐々に小さくなる様に組立てる。

次に上記のように構成した本発明の燃料電池の作用について説明する。燃料流通路7、及び酸化剤流通路8は、セパレーターブレート9に設けた流通路入口から出口にかけて徐々に山が高くなる凸部16，17により、溝断面積が徐々に小さくなるので、燃料流通路7及び酸化剤流通路8と流れる供給ガスの流速は、出口に近づくにつれて徐々に大きくなる。

第3図に、本発明で実施したセパレーター9に凸部を設け溝断面積を小さくし、供給ガス流速を大きくした場合（図中点線Aで示す）と、凸部を設けず溝断面積は大きい場合（図中実線Bで示す）

の電池特性を示している。ここでの凸部は、傾斜をつけず、単に供給ガス流速の増加が、電池特性に及ぼす影響のみを示している両者の流通溝断面積比は2：3である。第3図から燃料流通路7及び酸化剤流通路8を流れる供給ガス流速が大きい方が、供給ガス拡散効果が良好となり電池特性が良好であることがわかる。

これより本発明の燃料電池においては、前述した様に出口に近づくにつれて供給ガス流通溝面積を小さくする様に構成したので、燃料及び酸化剤が流通溝を通過する際、連続的に消費されて分圧が低下し、電気化学反応が抑制されるが、徐々に供給ガス流速を増加させる事で供給ガス拡散効果が良好になり、セル平面全体で、同程度の電気化学反応が生じるようになる。その結果セル平面の電流密度分布が均一となり、高利用率時もより電圧を安定に維持することができるだけでなく、電池の長寿命化にもつながる。

また供給ガス流通溝断面積の縮少化にリブ付電極を加工する事なく達成したので、リブ付電極の特徴であるマトリックス層のリン酸が減少すると吸蔵しているリン酸を補給し、長寿命化を促すいわゆる"リザーバー機能"をそこなうこと無く、またリブ付電極のガス拡散面積を減少させることなく先述の電池性能の向上をもたらすことができた。さらには、供給ガス流通溝断面積を小さくしたので、供給ガスが流通溝を通過する時の圧損が大きくなる。その結果セルを多数積層した時の配流効果が増大し各セルに供給ガスが均一に分配されスタック全体の利用率特性が良好となる。

〔発明の他の実施例〕

次に本発明の他の実施例を第4図を参照しながら説明する。第4図に示す如く、カソードリブ付電極及びアノードリブ付電極の酸化剤流通溝幅及び燃料流通溝幅を出口に近づくにしたがい、小さくなる様に構成したので、酸化剤流通溝及び燃料流通溝を流れる酸化剤及び燃料ガス実流速は大きくなり本実施例と同様な電池性能の向上をもたらす事ができる。

〔発明の効果〕

以上説明した様に本発明は次のような効果がある。アノード及びカソード電極の供給ガス流通溝断面積を、流通溝出口に近づくにつれて小さくなる様に構成したので、出口に近づくにつれて徐々に流速を増加させ供給ガス拡散効果を良好にすることでセル平面電流密度が均一となり、高利用率時もより電圧を安定に維持できるだけでなく、電池の長寿命化にもつながる利点がある。

また多数セルを積層した時に供給ガス流通溝断面積を小さくしたので、供給ガスが流通溝を通過する時圧損が大きくなる結果、配流効果が増大する利点がある。

4. 図面の簡単な説明

第1図(a)(b)は本発明の一実施例を示すセパレータープレート側面図及び積層セル部分側面図、第2図は従来セル平面の電流密度分布を示す特性図、第3図は本発明の効果を説明する特性図、第4図は他の実施例を示すセル側面図、第5図(a)(b)は従来の燃料電池を示す部分構成図と断面図である。

1…マトリックス　　2…アノードリブ付電極

3…カソードリブ付電極

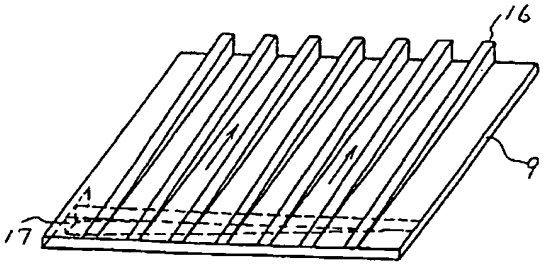
9…セパレータープレート

16…カソード溝に接する凸部

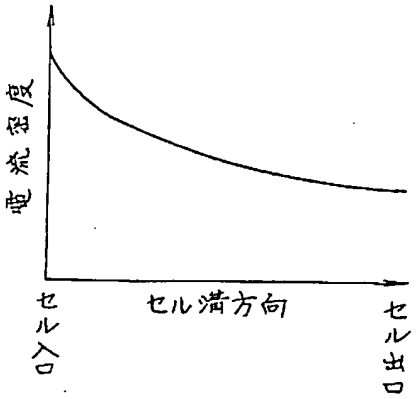
17…アノード溝に接する凸部

代理人　弁理士　則　近　憲　佑

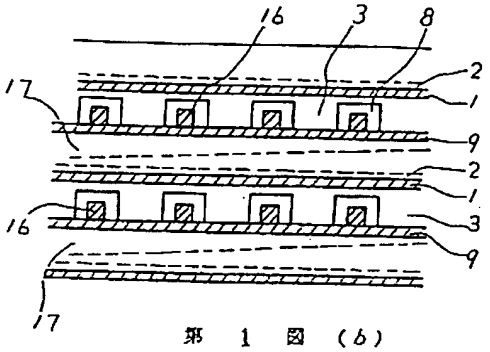
(ほか1名)



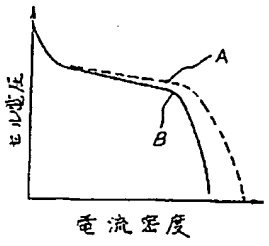
第 1 図 (a)



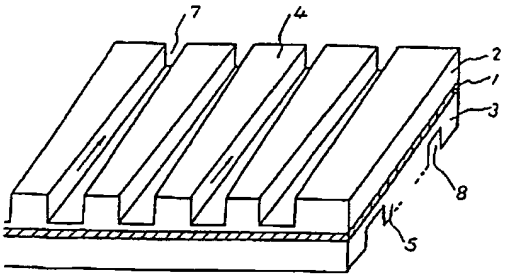
第 2 図



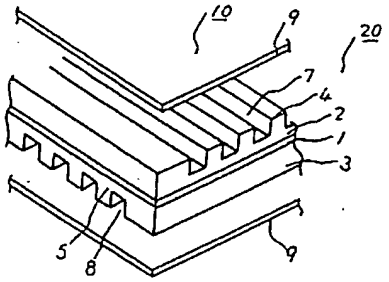
第 1 図 (b)



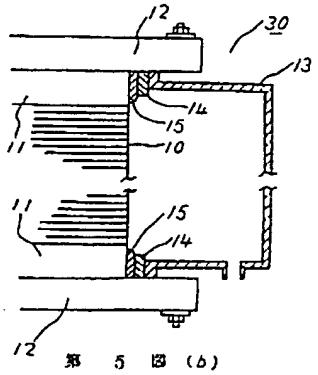
第 3 図



第 4 図



第 5 図 (a)



第 5 図 (b)

PAJ

TI - FUEL CELL

AB - PURPOSE:To improve the cell characteristic under high utilization area of supply gas while to improve the service life and the reliability by constructing such that the cross-section of fuel flow path and/or oxidizing agent flow path is larger at the upstream side than the down stream side.

- CONSTITUTION:The fuel flow path 7 and the oxidizing agent flow path 8 are formed such that the groove cross-section is decreased gradually by the projected sections 16, 17 having the ridge increasing gradually from the flow path inlet toward the outlet provided in separator plate 9. Consequently, the flow speed of supply gas in said paths 7, 8 will increase gradually toward the outlet, to uniform the current density on the cell plane resulting in improvement of cell characteristic and the service life.

PN - JP61256568 A 19861114
PD - 1986-11-14
ABD - 19870404
ABV - 011108
AP - JP19850096754 19850509
GR - E495

PA - TOSHIBA CORP
IN - SAKAI KATSUNORI

I - H01M8/02

Kokai (A) S61-256568
(51) Int. Cl^4 : H01M 8/02
(43) Publication Date: 14 Nov 1986
(54) Title: Fuel Cell
(21) Application Number: S60-96754
(22) Date of Application: 6 May 1985
(72) Inventor: Katsunori SAKAI of Toshiba Hama Kawasaki Works, 2-1, Ukishima-cho, Kawasaki-ku Kawasaki-shi.

(71) Applicant: Toshiba Corporation, 72 Horikawa-cho, Saiwai-ku, Kawasaki-shi
(74) Patent attorney: Kensuke NORICHIKA et al.

1) Title: Fuel Cell

2) Claims:

1. A fuel cell comprising a number of single cells with a electrolyte matrix holding an electrolyte between a pair of gas diffusion electrodes comprising a fuel passage for the flow of fuel and an oxidising agent passage for the flow of an oxidising agent, said single cells being stacked in series with intermediate gas-impermeable separator plates,
wherein the cross-sectional area is larger at the upstream side of said fuel passage and/or said oxidising agent passage than at the downstream side thereof.

2. The fuel cell according to claim 1, wherein said separator plate is provided with protrusions which are inserted into the fuel passage and/or the oxidising agent passage, the protrusions having a smaller cross-sectional area on the upstream side than on the downstream side.

3) Detailed description of the invention

Technical field

The present invention relates to fuel cells, especially to the structure of fuel passages or oxidising agent passages for fuel cells.

Background of the Invention

Conventional fuel cells which are devices for converting the energy in fuel directly into electrical energy are known. A fuel cell comprises a pair of porous electrodes with an ordinary electrolyte disposed between them. A fluid fuel such as hydrogen is placed contact with the back surface of one electrode, and a fluid oxidising agent such as oxygen is placed in contact with the back surface of the other electrode. The resultant electrochemical reaction allows electrical energy to be extracted from the two electrodes. As long as fuel and oxidising agent are supplied, electrical energy can be obtained at high efficiency. Fig 5 (a) and 5 (b) are local sectional view and a longitudinal sectional view showing the structure of a conventional fuel cell.

In fig. 5 (a), the single cell structure comprises a ribbed anode electrode 2 to which a catalyst is added at a surface which abuts an electrolyte-impregnated matrix 1, and on

the lower side, a ribbed cathode electrode 3 to which a catalyst is added at a surface which abuts the matrix 1, and which is formed from a porous material. The ribbed electrodes 2,3 have respective ribs 4,5 which form a plurality of parallel, regularly spaced channels 7,8 in mutually orthogonal directions. The channels 7,8 form the flow passages for the fluid fuel and the fluid oxidising agent respectively. Single cells 20 formed in this way are stacked with intermediate separator plates 9 that are non-gas-permeable, heat-resistant and phosphoric acid-resistant, forming a stacked cell 10.

As shown in fig. 5(b), sealing conductors 11 are placed on the top and bottom of the stacked cell 10. Clamps 12 arranged at the top and bottom fix the stack in the stacking direction to form a cell body 30. To supply and exhaust fluid fuel such as hydrogen and fluid oxidising agent, such as air, to the stacked cell body 30, a manifold 13 is fixed to the side of the cell body via a shaped fluoro-rubber packing 14, with a fluoro-resin seal 15 between the cell body and the shaped packing. Fuel and oxidising agent are supplied or exhausted to all the individual cells together.

The hydrogen contained in the fuel gas and the oxygen contained in the oxidising gas pass through respective flow channels 7,8 and are continuously consumed by the electrochemical reaction. Around the inlets to the flow channels 7,8, the partial pressure of the hydrogen and oxygen is high. Approaching the outlets of the channels 7,8, the partial pressure becomes lower. As a result, the electrochemical reaction occurs more easily near the inlets to the flow channels 7.8, where the partial pressure is high, and the current density distribution in the cell plane deteriorates towards the end of the channel, as shown in fig. 2.

In operation, the current density is calculated from the effective cell area, and because there are parts in which the current density is locally high, especially when operating at high utilisation factors, the current density approaches the critical current density in these regions and the overall characteristics of the cell are adversely affected. Furthermore, during long-term operation of the cell, parts having a locally high current density lead to an increase in phosphoric acid emission, and a reduction or deterioration in the reaction. The life of the cell is also substantially shortened.

Aim of the Invention

In view of the above-mentioned problems, the present invention aims to provide a reliable fuel cell having a uniform current density distribution in the fluid flow direction, favourable cell characteristics in regions of high gas utilisation factor, and a long operating life.

Summary of the Invention

To achieve this aim, the present invention is characterised by a fuel cell structure in which the cross-sectional area of the fuel passage and/or oxidising agent passage is larger on the inlet side than on the outlet side.

Embodiment

A first embodiment of the invention is described below with reference to the drawings.

As shown in fig. 1(a), a separator plate 9 is provided with protrusions 16 on the side abutting the ribbed cathode electrode 3. the protrusions being narrower than the width of the cathode channels 8, and the height gradually increasing from the cathode channel inlet to the outlet. The number of protrusions is the same as the number of cathode channels 8, and they are arranged in parallel in a regular pattern, corresponding to the channels.

Further, the other side of the separator plate 9, opposite the first protrusions 16 is provided with protrusions 17 which are a degree narrower then the width of the anode channels 7, and arranged in a direction which is orthogonal to the first protrusions 16, the protrusions 17 gradually increasing in height from the anode channel inlet to the outlet. The number of protrusions 17 is the same as the number of anode channels 7, and they are arranged in parallel in a regular pattern. corresponding to the channels.

As shown in fig. 1 (b), the cell is assembled in such a manner than protrusions 16,17 on the separator plate 9 meet the channels 7,8 for the electrodes 2,3, and the cross-sectional area of the fuel passage and the oxidising agent passage gradually decreases from the inlet to the outlet.

The operation of the fuel cell of the present invention, as described above, will now be explained. Because the protrusions 16,17 formed on the separator plate 9 gradually increase in height from the passage inlet to the passage outlet, the cross-sectional area of the fuel passage 7 and oxidising agent passage 8 gradually decreases. This means that the flow rate of the supplied gas flowing in the fuel passage 7 and the oxidising agent passage 8 gradually increases towards the outlet.

Fig. 3 shows the characteristic of the fuel cell in accordance with the present invention for a first case in which protrusions are formed on the separator plate 9, the cross-sectional area of the channels is small, and the flow rate of supplied gas is large (shown by the dotted line A), and for a second case in which no protrusions are formed on the separator plate 9, and the cross-sectional area of channels is large (shown by the unbroken line B). Here, the ratio of the cross-sectional areas of the two channels is 2:3, the protrusions are not inclined and only an increase in the flow rate of gas supplied has an effect on the cell characteristic. It can be seen from fig. 3 that the greater the flow rate of the gas flowing in the fuel passage 7 and oxidising agent passage 8, the more effective is the diffusion of the supplied gas, and the better the cell characteristic.

Because the fuel cell of the present invention has gas channels with a cross-sectional area that decreases towards the channel outlet, the partial pressures of the fuel and oxidising agent flowing in the channels (and continuously consumed) are reduced. This inhibits the electrochemical reaction, but because the flow rate of the supplied gas gradually increases, the diffusion effect on the supplied gas is improved, and the same amount of electrochemical reaction occurs across the whole plane of the cell. As a result, the current density is made uniform across the cell plane, and even at high utilisation factors, a higher voltage can be maintained stably, and also the life of the fuel cell can be extended.

Furthermore, since the reduction in cross-sectional area of the supplied gas flow channels can be achieved without manufacturing ribbed electrodes, the phosphoric

acid of the matrix layer which is a feature of the ribbed electrodes, is reduced and the occluded phosphoric acid is replenished. The so-called "reserver function" which extends the life of the fuel cell is not impaired, the gas diffusion area of the ribbed electrode is not diminished, and the above-mentioned cell performance can be increased. Moreover, since the cross-sectional area of the supplied-gas channels is smaller, when the gas is flowing in the channels, the pressure loss is larger. As a result, when several cells are stacked together, the flow distribution effect is increased, and the gas supplied is evenly distributed to each cell, so that the utilisation characteristic of the whole stack is improved.

Further embodiment of the invention

A further embodiment of the present invention is described below, with reference to fig 4. The channel width of the oxidising agent channel and the fuel channel of the cathode ribbed electrode and the anode ribbed electrode decreases towards the outlet of the channels, so that the actual flow rate of the oxidising agent and fuel gas flowing in the respective channels is increased, and the cell performance can be improved in a similar manner to the main embodiment.

Effect of the Invention

In accordance with the above description, the present invention has the following advantages. Since the cross-sectional areas of the supply-gas channels for the anode and cathode electrodes decreases towards the flow channel outlet, the flow rate gradually increases as the outlet is approached, and the diffusion effect of the supplied gas is improved. Consequently, the current density in the cell plane is made uniform, and even at high utilisation factors, a higher voltage can be stably maintained, and the operating life of the cell can be extended.

When several cells are stacked together, because the cross-sectional area of the supply gas channel is reduced, when the supplied gas flows in the flow channels, the pressure loss is increased. As a result, the flow distribution is improved.

4. Brief description of the drawings

Fig. 1 (a) (b) is a side view of a separator plate and a side view of a stacked cell arrangement in accordance with one embodiment of the present invention.
Fig. 2 is a characteristic curve of the current density distribution of a conventional cell plane.
Fig. 3 is a characteristic curve for explaining the advantages of the present invention.
Fig. 4 is a side view of a cell in accordance with a further embodiment of the present invention.
Fig. 5 (a, b) is a structural drawing and a longitudinal section through a conventional fuel cell.

1...Matrix
2...Ribbed anode electrode
3...Ribbed cathode electrode
9...Separator plate
16...Protrusion which abuts cathode channel

17...Protrusion which abuts anode channel

This Page is Inserted by IFW Indexing and Scanning Operations and is not part of the Official Record

BEST AVAILABLE IMAGES

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images include but are not limited to the items checked:

- ☑ BLACK BORDERS
- ☐ IMAGE CUT OFF AT TOP, BOTTOM OR SIDES
- ☐ FADED TEXT OR DRAWING
- ☐ BLURRED OR ILLEGIBLE TEXT OR DRAWING
- ☐ SKEWED/SLANTED IMAGES
- ☐ COLOR OR BLACK AND WHITE PHOTOGRAPHS
- ☐ GRAY SCALE DOCUMENTS
- ☑ LINES OR MARKS ON ORIGINAL DOCUMENT
- ☐ REFERENCE(S) OR EXHIBIT(S) SUBMITTED ARE POOR QUALITY
- ☐ OTHER: _____

IMAGES ARE BEST AVAILABLE COPY.
As rescanning these documents will not correct the image problems checked, please do not report these problems to the IFW Image Problem Mailbox.